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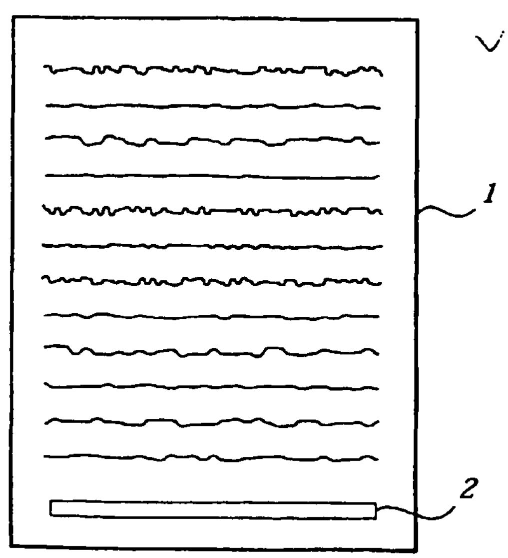
(54) Title: METHOD AND SYSTEM FOR STORING A CODING PATTERN



(57) Abstract: A product (1) with stored non-sequential data is provided by means of a method which comprises the step of coding the data (6, 52) to a coding pattern (2) by means of at least one sequence (32) with symbols (3, 24) which have the characteristic that an arbitrary subsequence of a predetermined magnitude of the sequence (32) unambiguously defines the position of the subsequence (34, 35) in the sequence. Then the coding pattern is reproduced on a product (1). A user unit is adapted to record and decode the coding pattern (2).

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METHOD AND SYSTEM FOR STORING A CODING PATTERN

Field of the Invention

The present invention relates to a method for storage of information or data and a device adapted to read data stored by means of the method.

Background Art

There are a plurality of known methods for storage of data. The traditional technique of storing written information is to store text in printed products such as books and newspapers. There are, however, several drawbacks of storing text in book form. One of the drawbacks is that books require much space. To achieve storage requiring less space, documents have for a long time been stored on microfiche. For a high degree of compaction, it is, however, necessary to use photographic films for such storage since ordinary paper has a strictly limited packing density. The storage alternatives to books which are advancing most rapidly are those based on the use of computers. A plurality of storage media for digital information are available. Examples of such storage media are RAM, magnetic media and optical media, such as optical discs. Another technique of storing information that can be read optically is bar codes which are used to a great extent in the retailing of everyday commodities when prices are included.

It is in some cases desirable to distribute text stored in a compact fashion. A drawback of using computers in such cases is that the user must then be electronically connected with the distributor of the stored information. An alternative is distributing microfiche or magnetic or optical data storage media containing the information that is to be distributed. However, it is relatively expensive to distribute data storage media or microfiche to a large group of people.

There is thus a need for an alternative method for compact storage of data and an alternative device for recording data stored by means of the method.

Summary of the Invention

An object of the present invention is to provide a method for compact storage of non-sequential data.

A further object of the present invention is to provide a method for compact storage of written text which allows easy distribution to a plurality of users without using electronic transmission.

One more object of the present invention is to provide a method for storage of a command which controls a computer.

Another object of the present invention is to provide a device for recording of information which has been stored by means of the method according to the present invention.

These and other objects are achieved by a method, a device and use according to the appended claims.

A basic idea of the present invention is to store text and other data by means of a matrix with symbols, which matrix can be recorded optically.

A method for storage of non-sequential data according to the invention is characterised in that it comprises the steps of coding the data to a coding pattern by means of at least one sequence with symbols which have the characteristic that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence, and reproducing the coding pattern on a product.

In this context, the term "product" relates to all possible articles on which a coding pattern can be applied. In the first place, sheets of paper in newspapers, books as well as loose sheets of paper are intended, but also other articles, such as bulletin boards, can be provided with a coding pattern.

Data relates to information such as text or other information. Data also relates to, for example, a command to a computer. This type of information is usually non-periodic.

The term non-sequential defines that the data is arbitrary in the sense that it is not a sequence of numbers in one or more dimensions. Such a sequence may easily be stored as a mathematical expression.

The product can be an arbitrary product on which one wants to have coded information. By coding the information by means of a sequence of the above type a code is made possible, which is relatively insensitive to how it is read by a user unit. At the same time, compact storage of the information is permitted. As mentioned above, the document may consist of any document whatever.

According to a preferred embodiment, the matrix is reproduced on a page in a book, the string of text being the text on the page of the book. It will thus be possible for a user to optically record the contents of the entire page of the book by recording the matrix with symbols.

Preferably, the data is converted into a set of data values, the pattern being arranged in such manner that it comprises portions of said at lest one sequence in a coding pattern, said portions being of at least the same magnitude as the subsequences of a predetermined magnitude, so that each of the data values codes a group each of at least two sequence portions in the coding pattern.

By coding the data in such manner that groups of at least two sequence portions are required for each data value, the coding pattern will be such that an arbitrary part of one sequence portion and the corresponding part of another sequence portion define a data value.

The data is advantageously coded with only one sequence so that the position of the subsequence in the sequence constitutes a sequence value and the relation-

ship between sequence values from different sequence portions defines the data values.

By using only one sequence, the coding and the recording of the coding pattern are simplified to a considerable extent. A user unit which is used to read the coding pattern can then process all parts of the coding pattern in the same way. It is also advantageous that only two sequence portions are required to code a data value since the coding pattern can then be made more compact.

Advantageously, each of the data values is defined by the difference between the sequence values for two subsequences from different sequence portions. Although some other relationship between the sequence values can be used, it is advantageous to use the difference between the sequence values since it simplifies the method when reading the coding pattern.

According to another embodiment each of the data values is defined by a single sequence value. According to this embodiment the subsequences are arranged in a pattern so that the subsequences are arranged separated from each other. Preferably, the subsequences are arranged in a row so that the symbols of the subsequences may be recorded in a single stroke with a reading pen.

The sequence portions are preferably juxtaposed in a matrix so that each of the data values is defined by the difference between the sequence values for two adjoining subsequences from corresponding parts of the sequence portions in the matrix. As a result, a user unit can easily convert the matrix and its subsequences with symbols into subsequences with values. It is possible for a user unit to convert the subsequences with values into data values. Since the data values are defined by difference values, the data values will be independent of which parts of the sequence portions are recorded.

It is, of course, possible to arrange the sequence portions in a way other than in a matrix. However, it

facilitates the recording of the sequence portions that they are arranged in a matrix.

The sequence portions advantageously code also at least part of a position value which defines the serial number of the sequence portion. This means that it is not necessary to record the entire coding pattern on the same occasion since the order of the different parts can be obtained from the position value. This facilitates recording of the matrix since a user unit which records the matrix can then decide whether sequence portions have already been recorded previously. In the case of missing certain sequences in connection with the recording when a user unit is scanned across the coding pattern, it will thus be possible to record the missed sequences on a later occasion and place them in the correct position by means of the position values. The position values are also of assistance when checking that no sequence has been missed.

Advantageously, part of a difference value defines part of a position sequence, which is arranged in such manner that an arbitrary position sequence part of a predetermined magnitude unambiguously defines the position of the position sequence part in the position sequence.

In the case where the difference values do not define position values, it is advantageous to reproduce the coding pattern on the product together with a marking which indicates a reading direction. Thus, it is ensured that the coding pattern and, thus, the data are not recorded in reverse order. If there is a position code, it is not necessary to have such a marking. The marking with the reading direction need be supplemented with the putting together of images so as to guarantee that each sequence is recorded only once.

Even if the data can be arbitrary data, it is preferably characters which are converted into data values. Alternatively, the data consists of, for example, a command to a computer.

The conversion of the characters into data values can be carried out in several ways. Advantageously, the text is first compressed by means of some prior art compressing method so that the data that is to be coded is minimised. Then each character in the coded data is converted into data values.

Preferably, the matrix is arranged in such manner as to comprise only columns with sequences which define sequence values. As a result, the matrix will be as compact as possible. It goes without saying that it is possible to arrange the matrix so as to comprise also other information.

According to a less preferred embodiment, the matrix also comprises other sequences with symbols. These can serve as delimitation between the sequences which define sequence values. However, the matrix will be less compact than in the case where the preferred embodiment is used.

On a product according to the invention data is stored in the form of a coding pattern which codes the data. The product is characterised in that the coding pattern codes the data, the coding pattern consisting of sequence portions with symbols which each comprise at least a subsequence of a sequence which is arranged so that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence.

A product according to the invention codes data in a more compact manner than does a bar code since a product according to the invention can have information stored in two dimensions.

Preferably, the coding pattern codes a set of data values, each of the data values being coded by a group each of sequence portions consisting of at least two sequence portions.

Consequently a code is permitted, which can be made independent of the reading in one dimension.

The symbols on a product according to the invention can have many different kinds of appearance. According to an embodiment, the symbols consist of markings, the size of the markings defining the value of the symbol.

According to an alternative embodiment, each of the symbols comprises a raster point and a marking, the value of each symbol being indicated by the position of said marking in relation to the raster point.

A user unit for optical recording of information according to the present invention comprises an image sensor and is adapted to optically record images from a surface by means of the image sensor. The user unit is characterised in that it is adapted, in response to the fact that a recorded image comprises a predetermined number of subsequences with symbols, each of the subsequences unambiguously corresponding to a position in a predetermined sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude unambiguously defines a position in the sequence, to convert the predetermined number of subsequences into data.

Preferably, the user unit also comprises a memory intended for storage of data which corresponds to the data value. Data stored in the memory can then be transmitted to some other unit, such as a computer.

Instead of, or together with, a memory, the user unit may comprise a display and can be adapted to show on the display data which corresponds to the data value.

The user unit can be equipped with a loudspeaker via which the user unit is adapted to transmit sound corresponding to the data.

A user unit according to the invention is advantageously adapted to convert the predetermined number of subsequences into data values and to convert each data value into only one character. This means that the memory can be small since a reference table which is stored in

the memory need only contain connections between the number of characters used and their corresponding symbols.

Alternatively, a user unit according to the present invention is adapted to convert each data value into one or more characters. Thus, the data values are converted into entire words, word parts or endings. A matrix which is made up in this manner will, of course, be more compact than if each character has its own data value. A drawback is, however, that a larger memory is necessary in the user unit. Besides, that part of the matrix which need be recorded for a word to be defined must be larger than if each character has its own data value.

Of course, the user unit is adapted to convert the coding pattern in dependence on how it is created.

Thus the coding pattern is converted in reverse order to how it has been stored.

The conversion of the subsequences with symbols into data values is preferably made by converting the symbols into values, converting the subsequences with values into sequence values, calculating the differences between the sequence values and converting the differences into data values.

The user unit is advantageously adapted to use part of the difference between the sequence values for determining the relative positions of the subsequences. Since more than one image is recorded in the inputting of a matrix, there is a risk that certain parts of the matrix are recorded in more than one image. By the user unit using part of the difference to determine the relative positions of the sequence parts, it is possible to exclude such information as corresponds to sequence parts that have already been recorded.

Since the conversion between data and data values is carried out by means of a predetermined relationship, the user unit must have information about how the data was converted into data values when the matrix was formed.

A memory medium according to the invention can be read by a computer and has a program stored thereon. The memory medium is characterised in that the program makes a computer record an input signal corresponding to an image, and, in response to the fact that the image comprises a predetermined number of subsequences with symbols, each of the subsequences unambiguously corresponding to a position in a predetermined sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude unambiguously defines a position in the sequence, convert the predetermined number of subsequences into data.

Such a program can be executed in an arbitrary computer but is advantageously executed in a reading pen which comprises the necessary hardware for recording images.

If the coding pattern is printed by a carbon-based black ink absorbing infrared light and the printed text is printed with an ink which is not carbon-based and does not absorb infrared, the coding pattern may be sensed by an infrared sensor, without interference by the printed text.

The above features can, of course, be combined in the same embodiment.

With a view to further elucidating the invention, detailed embodiments thereof will be described below, without the invention however being considered to be restricted thereto.

The accompanying drawings are only schematic and, thus, certain dimensions are greatly exaggerated so as to illustrate the invention more distinctly.

Brief Description of the Drawings

Fig. 1 shows a document in the form of a page in a book with a coding pattern according to a preferred embodiment of the present invention.

Fig. 2 illustrates in more detail the coding pattern in Fig. 1.

Fig. 3 illustrates a sequence which can be used to code data according to the present invention.

Fig. 4 shows an embodiment of symbols which can be used in the coding pattern in Figs 1 and 2.

Fig. 5 shows how part of the coding pattern is converted into characters.

Fig. 6 shows a user unit according to a preferred embodiment of the invention.

Fig. 7 shows the conversion of a matrix into data values and a position value.

Fig. 8 shows the conversion of the coding pattern into sequence values.

Fig. 9 shows how part of an alternative embodiment of a coding pattern is converted into data values.

Detailed Description of the Invention

Fig. 1 shows a document 1 with a coding pattern according to a preferred embodiment of the present invention. The coding pattern consists of a matrix whose outer boundary 2 is marked with the frame 2.

Fig. 2 shows in more detail the coding pattern 2. The matrix comprises a plurality of symbols 3 arranged in sequence portions 4 in columns in the matrix, each symbol 3 defining the value "0", "1", "2", or "3". Each column with symbols is a sequence portion of a sequence with 512 symbols. An arbitrary subsequence, which consists of five symbols, defines unambiguously the position of the subsequence in the sequence. The sequences in the different columns are displaced in relation to each other. Fig. 1 also shows a marking 31 which indicates in which direction the matrix is to be recorded for the string of characters to be recorded. In Fig. 2, all symbols are marked with identical symbols. However, the symbols are of course different dependent on which value they represent.

Fig. 3 illustrates the appearance of a sequence 32 which is used in the invention. The sequence 32 comprises 512 values 33, each of which is either "0", "1", "2", or

"3". An arbitrary subsequence 34, 35 with 5 values defines unambiguously a sequence value which corresponds to the position of the subsequence in the sequence 32. Each subsequence appears only once in the sequence. Thus, the first subsequence 34 corresponds to the value "0" and the second subsequence 35 to the value "1". In Fig. 2, the columns consist of sequence portions of such sequences in which the values have been converted into symbols. Sequences of this kind are described in "Pseudo-Random Sequences and Arrays" by F. Jessie MacWilliams and Neil J. A. Sloane in "Proceedings of the IEEE Vol. 64, No. 12, December 1976".

Figs 4a-d show an embodiment of a symbol which can be used in the matrix in Fig. 1 according to the invention. The symbol comprises a virtual raster point 28 which is represented by the intersection between the raster lines, and a marking 29 which is in the form of a point. The value of the symbol depends on where the marking is located. In the Example in Fig. 4, there are four possible locations, one on each of the raster lines extending from the raster points. The displacement from the raster points is the same for all values. The symbol has in Fig. 4a the value "0", in Fig. 4b the value "1", in Fig. 4c the value "2" and in Fig. 4d the value "3". In other words, there are four different types of symbols. Each symbol can thus represent four values "0-3".

Fig. 5 shows a part 5a of the matrix 2 in Fig. 1 in greater detail. The submatrix 5 contains five subsequences 36 arranged in columns in the submatrix. Fig. 5a also shows the virtual raster 37 in relation to which the symbols are arranged. Fig. 5 b shows the matrix when the symbols have been converted into values.

Fig. 6 shows a user unit according to a preferred embodiment of the present invention. The user unit is a reading pen 14 which is arranged for recording a coding pattern as shown in Fig. 2. The reading pen is intended to be held by the user's hand to record images from a

base. The reading pen comprises a light-emitting diode 7 for illuminating the surface which is to be recorded, an image sensor 8 in the form of a CCD for recording of images, an image processing means 9 and a memory 10. In front of the CCD there is arranged a lens system 38 which is intended for imaging of the coding pattern on the CCD. The reading pen 14 further comprises a battery 12 for power supply and buttons 13 by means of which the reading pen is switched on. The reading pen is provided with a transmitter 16 for transmitting recorded information to a computer 15, which in turn is provided with a receiver 17 for receiving information from the reading pen. The transmitter and the receiver communicate, for example, by IR or by radiowaves. The information recorded by means of the reading pen can, consequently, easily be transmitted to the computer for further processing. The reading pen is also provided with a display 21 for presentation of the information recorded by means of the reading pen 14. The reading pen 14 is also provided with a loudspeaker 55 to transmit sound corresponding to the data.

With reference to Figs 2, 5 and 6, the recording of a coding pattern will now be described. When the reading pen is passed across the matrix 2 with symbols 3, an area is recorded, which at least comprises a first area 5 comprising a submatrix of the size five times five symbols 3. The symbols are one of the four different symbols shown in Fig. 4. The image processing means 9 converts the recorded image into a matrix with five times five symbols. Then the reading pen converts the subsequences 36 in the matrix into subsequences 39 with values 40. Each subsequence with values correspond to a sequence value 27 which corresponds to the position in a sequence with 512 values, each of which is either "0", "1", "2" or "3". If an image is recorded which is displaced one row in the matrix, sequence values are obtained, which correspond to the next position in the sequence. The user unit converts the subsequences 39 into sequence values 27.

Then the user unit calculates data values 26 as the difference modulo 1024 between the sequence values 27 for adjoining columns. By the sequence values 27 increasing to the same extent for each column if the recorded image is displaced in the direction of the column, the data values, which equal the difference between the sequence values 27, are independent of the height at which the image is recorded. The data values are then converted into binary form and the eight least significant bits in each data value are converted into characters 6 which are stored in the memory 10, while the two most significant bits from four adjoining data values are converted into a position sequence part. Thus it is possible to code a total of 256 different characters. The position sequence part constitutes part of a position sequence similar to the sequence in Fig. 3 and defines unambiguously a position in the position sequence and constitutes a position value for the columns.

In Fig. 5, the characters 6 are characters in a text. However, it is preferred for the characters 6 to be characters in a compressed text so that the string of characters which consists of the characters 6 need be converted so as to obtain text en clair.

The position values for the columns are used to determine whether a character from a subsequently recorded image has already been stored in the string of characters in the memory. This is usable since the next image which is recorded comprises, for example, a second area 22 which comprises parts of the first area 5. When the subsequences in the second area 22 are converted into characters, the characters will partly be the same as those recorded when the first area 5 was recorded. By the position value being given by the difference values, the previously stored characters can be dropped. A coding pattern codes, for example, the series [(0, 12), (1, 25), (2, 37), (3, 82), (4, 24), (5, 16)] in which the first value in each pair of values corresponds to a position

value and the second value corresponds to a data value. In a first image, the series [(0, 12), (1, 25), (2, 37), (3, 82)] is recorded. In a second image, the series [(2, 37), (3, 82) (4, 24), (5, 16)] is recorded. Thus, the values "37" and "82" are recorded twice. The position values indicate, however, that they have been recorded even the first time, which makes it possible to produce the correct series once more.

A further example of when the positions of the subsequences are important is when the reading pen is quickly passed across the coding pattern. Then there is a risk that some information is not recorded. By having a position code in subsequences, it will be possible to pass the reading pen across the coding pattern once more, thereby recording the information that was not recorded the first time. This is illustrated in Fig. 7. Fig. 7 shows a small part 43 of a coding pattern in the form of a plurality of symbols 42 arranged in columns 45 in a matrix. It is thus sufficient to record a subsequence consisting of five symbols of each column 45. When the reading pen is passed across the coding pattern, several images are recorded. A first image 39 and a second image 40, which are recorded by the reading pen, are separated. Since some of the symbols in the pattern have not been recorded in an image, some information is missing. It is then possible to pass the reading pen across the coding pattern a second time to record a third image 46 which contains information from the columns that were missing in the first image 39 and in the second image 40. By the subsequences containing position information, it is possible to enter the information from the third image 46 in the correct position in relation to the information from the first image 39 and second image 40. A coding pattern codes, for example, the series [(0, 12), (1, 25), (2, 37), (3, 82) (4, 24), (5, 16)], where the first value in each pair of values indicates the position value and the second value indicates the data value. In a first record-

ing, the series [(0, 12), (1, 25), (2, 37), (4, 24), (5, 16)] is recorded. In a second recording, the series [(0, 12), (1, 25), (2, 37), (3, 82) (4, 24)] is recorded. Since the data value "82" which corresponds to the position value "3" is included in the second series, the complete series can be produced.

According to a preferred embodiment, each difference value codes only part of a position value. This is illustrated in Fig. 7. The matrix 53 with symbols 54 is converted into sequence values S_1-S_5 in the same manner as described above. The difference between the sequence values forms a set of data values D_1-D_4 and a set of subposition values P_1-P_4 which together form a sequence defining a position value which indicates the position of the matrix in the coding pattern.

Fig. 8 also illustrates how the information from images, which have been recorded at different heights in the matrix, is processed. The first image 40 contains five times five symbols. The symbols are converted into values as described in connection with Fig. 5. The values in the columns are then converted into sequence values which correspond to the position of the subsequence in the sequence. The five subsequences with symbols which correspond to the columns in the first image 40 are thus converted into a first set of five sequence values 47. The first set of five sequence values 47 is then converted into a first set of difference values 48, which in turn are converted into characters in the same way as described in connection with Fig. 5. When a third image 41 containing five times five symbols is recorded, the five subsequences consisting of five symbols are converted into a second set of five sequence values 49. The second set of five sequence values 49 is then converted into a second set of difference values 50 which in turn are converted into characters in the same way as described in connection with Fig. 5. Each of the sequence values 49 in the second set is four units greater than the

sequence values 47 in the first set since they are fetched further down in the sequences of which the sequence parts consist a part. However, each of the difference values 48 in the first set of difference values is equal to the corresponding difference value in the second set of difference values. Thus, the difference values are independent of at what height in the matrix 43 the images have been recorded.

When producing the matrix in Fig. 5, each character 6 in a string of characters is first converted into data values by means of a reference table which is stored in the memory. The data values consist of eight bits. Difference values 26 are then produced by adding position information in the form of two binary bits to the data values. The position information 30 is selected in such manner that four successive difference values 26, 48, 50 give a position subsequence which unambiguously defines a position value which gives a position subsequence which unambiguously determines a position in a position sequence. Parts of identical sequences are then arranged in columns in the matrix. The identical sequences are such that a subsequence with five successive values from the sequence unambiguously determines a sequence value 27 which corresponds to the position of the subsequence in the sequence. The parts of the sequences are arranged in such manner that the set of differences between the sequence values for the sequence parts, which have been taken from the same rows in the matrix, corresponds to the difference values 27. Subsequently the values 40 in the sequences are converted into symbols 3.

In fig 9 another embodiment of a coding pattern is shown in which the entire coding pattern has a height 64 corresponding to the length of a subsequence, i.e. five symbols 60 in this case. The coding pattern is of a similar type as described in connection with fig. 5, i.e. the value of a symbol depends on the position of a marking 60 in relation to a virtual raster with raster lines

65. The distance 61 between different raster lines 65 is 0.3 mm in this embodiment. With this distance between the raster points the coding pattern becomes considerably robust while at the same time being compact. The symbols in the square 66 are converted into subsequences 62 as described in connection with fig 5. The subsequences are in turn converted into sequence values 63. According to this embodiment each sequence value correspond to a character and a position code. The sequence value "96" corresponds for example to the character " " (space) and the position code "17". According to this embodiment of the invention the reading pen thus has to record all symbols in the height of the coding pattern in order to be able to convert into text. An advantage of this embodiment is that each character may be recorded by recording only one column of symbols.

In a preferred embodiment, 6*6 symbols are used for coding the pattern. A more detailed explanation of how the coding is done appears from Applicant´s PCT patent applications Nos. WO 00/73983, PCT/SE00/1667 and WO 01/16691, the contents of which are included in the present specification by reference.

The above embodiments are to be considered examples only.

A person skilled in the art realises that the above embodiments can be varied in a number of ways without departing from the inventive idea. For example, it is not necessary that the user unit be a single integrated unit.

It is not necessary for the invention that a display be arranged directly on the user unit.

Although the examples above only illustrate that the sequence portions are arranged in columns in a matrix, this is not necessary for the invention. The sequence portions can be arranged in an arbitrary manner.

It goes without saying that the sequences that are used to code the data need not be 512 character long.

Of course any number of symbols may be used to code a value.

CLAIMS

1. A method for storage of non-sequential data, c h a r a c t e r i s e d in that it comprises the steps of

coding the non-sequential data (6, 52) to a coding pattern (2) by means of at least one sequence (32) with symbols which have the characteristic that an arbitrary subsequence (34, 35) of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence (34, 35) in the sequence (32), and

reproducing the coding pattern (2) on a product.

2. A method as claimed in claim 1, c h a r a c t e r i s e d in that it also comprises the step of converting the data (6, 52) into a set of data values (26), the pattern being arranged so as to comprise sequence portions of said at least one sequence in a coding pattern, said sequence portions being at least of the same magnitude as the subsequences of a predetermined magnitude, so that each of the data values is coded by a group each of at least two sequence portions (4) in the coding pattern.

3. A method as claimed in claim 1, c h a r a c t e r i s e d in that it also comprises the step of converting the data (6, 52) into a set of data values (26), the pattern being arranged so as to comprise sequence portions of said at least one sequence in a coding pattern, said sequence portions being of the same magnitude as the subsequence of a predetermined magnitude, so that each of the data values is coded by one sequence portion (4) in the coding pattern.

4. A method as claimed in claim 2, c h a r a c t e r i s e d in

that the data (6, 52) is coded with only one sequence (32),

that the position of a subsequence in the sequences constitutes a sequence value (27) and

that the relationship between the sequence values (27) from different sequence portions (4) defines the data values.

5. A method as claimed in claim 2 or 4, c h a r a c t e r i s e d in that each of the data values is defined by the difference between the sequence values (27) for two subsequences (39) from different sequence portions.

6. A method as claimed in claim 5, c h a r a c t e r i s e d in that the sequence portions (4) are juxtaposed in a matrix (2) in such manner that each of the data values is defined by the difference between the sequence values (27) of two adjoining subsequences from corresponding parts of the sequence portions in the matrix (2).

7. A method as claimed in any one of claims 2-6, c h a r a c t e r i s e d in that the sequence portions also code at least part (30) of a position value which defines the serial number of the sequence portion.

8. A method as claimed in any one of the preceding claims, c h a r a c t e r i s e d in that the data is characters, and that the characters are converted into data values.

9. A product on which non-sequential data (6, 52) in the form of a coding pattern (2) is stored, which codes the data (6, 52) c h a r a c t e r i s e d in that the coding pattern (2) consists of sequence portions (4) with symbols (3) which each comprise at least a subsequence of a sequence which is arranged so that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence.

10. A product as claimed in claim 9, c h a r a c t e r i s e d in that the coding pattern codes a set of data values, each of the data values coding a group each

of sequence portions (4) consisting of at least two sequence portions.

11. A product as claimed in claim 9 or 10, c h a r a c t e r i s e d in that the symbols (3, 24) consist of markings, the size of the markings defining the value of the symbol.

12. A product as claimed in claim 9 or 10, c h a r a c t e r i s e d in that each of the symbols (3, 24) comprises a raster point (28) and a marking (29), the value of each symbol being indicated by the position of said marking (29) in relation to the raster point (28).

13. A product as claimed in any one of claims 9, 10, 11 or 12, c h a r a c t e r i s e d in that the product (1) is a sheet of paper.

14. A product as claimed in any one of claims 9-13, c h a r a c t e r i s e d in that the coding pattern (2) codes text.

15. A product as claimed in any one of claims 9-13, c h a r a c t e r i s e d in that the coding pattern (2) codes a command.

16. A user unit for optical recording of information, which comprises an image sensor (8) and which user unit (11) is adapted to optically record images from a surface by means of the image sensor (8), c h a r a c t e r i s e d in that it is adapted, in response to the fact that a recorded image comprises a predetermined number of subsequences with symbols, each of the subsequences unambiguously corresponding to a position in a predetermined sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude unambiguously defines a position in the sequence, to convert the predetermined number of subsequences into non-sequential data (6, 52).

17. A user unit as claimed in claim 16, c h a r a c t e r i s e d in that it also comprises a display, and that it is adapted to show data on the display.

18. A user unit as claimed in claim 16, c h a r - a c t e r i s e d in that it further comprises a loudspeaker, and that it is adapted to transmit, by means of the loudspeaker, sound corresponding to the data value.

19. A user unit as claimed in any one of claims 16-18, c h a r a c t e r i s e d in that it is adapted to convert the symbols (3, 24) into subsequences with values,

to convert the subsequences with values into sequence values (27),

to calculate difference values (26) as the difference between the sequence values (27),

to convert the difference values (26) into data values, and

to convert the data values into data (6, 52).

20. A user unit as claimed in claim 19, c h a r - a c t e r i s e d in that some of the difference values (26) are used to determine the relative positions of the subsequences.

21. A user unit as claimed in claim 20, c h a r - a c t e r i s e d in that it is adapted to use the relative position of the subsequences to decide whether data (6, 52) corresponding to a data value has been previously recorded.

22. Use of a coding pattern for storage of text, said coding pattern (2) consisting of sequence portions (4) with symbols (3) which each comprise at least a subsequence of a sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence.

23. A computer-readable memory medium, on which a program is stored, c h a r a c t e r i s e d in that the program makes a computer (14)

record an input signal corresponding to an image, and

in response to the fact that the image comprises a predetermined number of subsequences with symbols (3, 24), each of the subsequences unambiguously corresponding to a position in a predetermined sequence (32) which is arranged in such manner that an arbitrary subsequence (34, 35) of a predetermined magnitude unambiguously defines a position in the sequence (32), convert the predetermined number of subsequences into non-sequential data.

24. A storage medium as claimed in claim 23, characterised in that the program makes the computer output a signal to a display unit for presentation of the data.

25. A method for storage of non-sequential data, characterised in that it comprises the steps of

converting the data (6, 52) into a set of data values (26),

coding the data values (26) to a coding pattern (2) by means of at least one sequence (32) with symbols which have the characteristic that an arbitrary subsequence (34, 35) of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence (34, 35) in the sequence (32), the pattern being arranged so as to comprise sequence portions of said at least one sequence in a coding pattern, said sequence portions being at least of the same magnitude as the subsequences of a predetermined magnitude, wherein the sequence portions also code at least part (30) of a position value which defines a serial number of the sequence portion, and

reproducing the coding pattern (2) on a product.

26. A method for storage of data, characterised in that it comprises the steps of

coding the data (6, 52) to a coding pattern (2) by means of at least one sequence (32) with symbols which have the characteristic that an arbitrary subsequence

(34, 35) of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence (34, 35) in the sequence (32), and

reproducing the coding pattern (2) on a product.

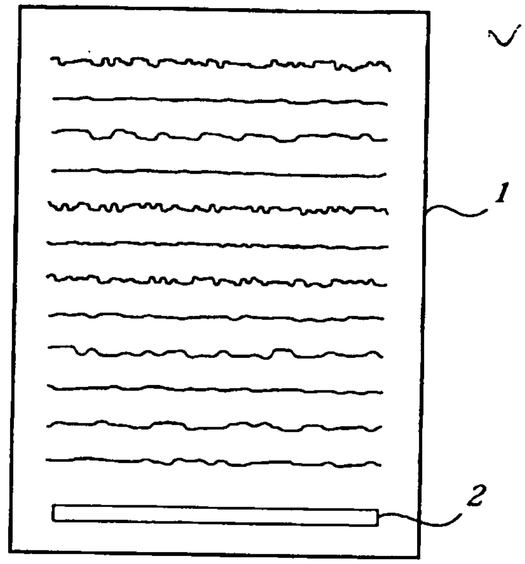

Fig. 1

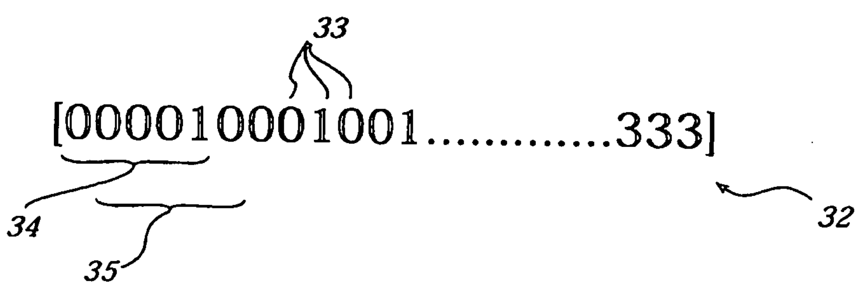

Fig. 3

2/6

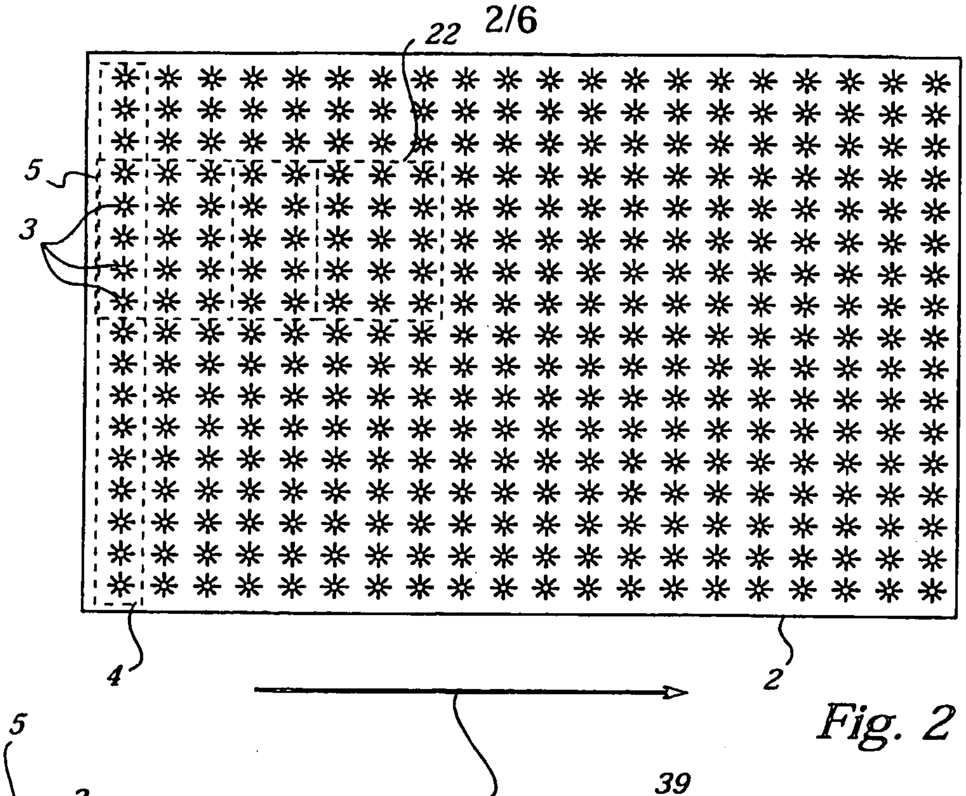

Fig. 2

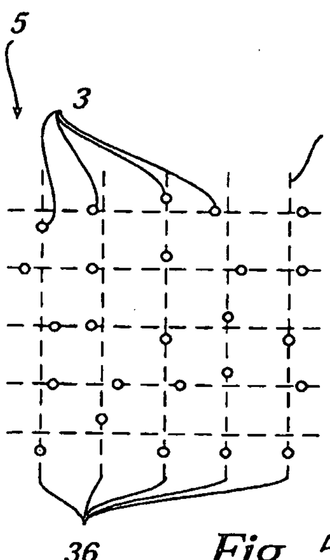

Fig. 5a

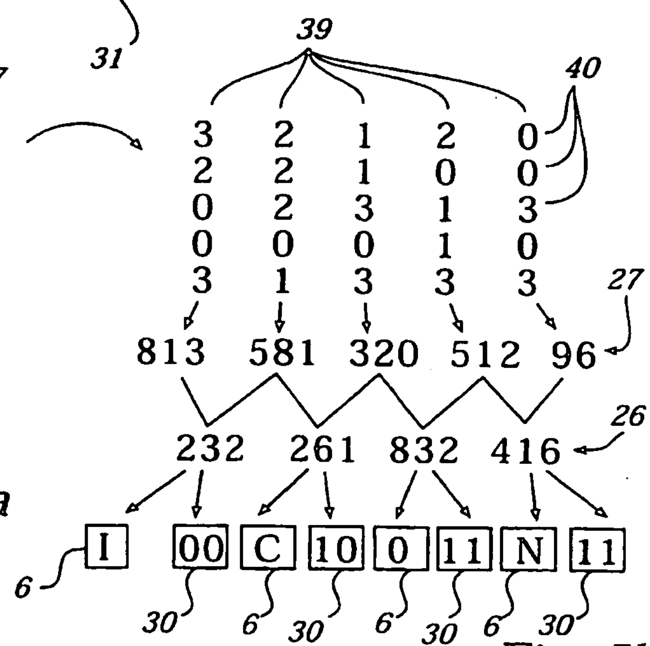

Fig. 5b

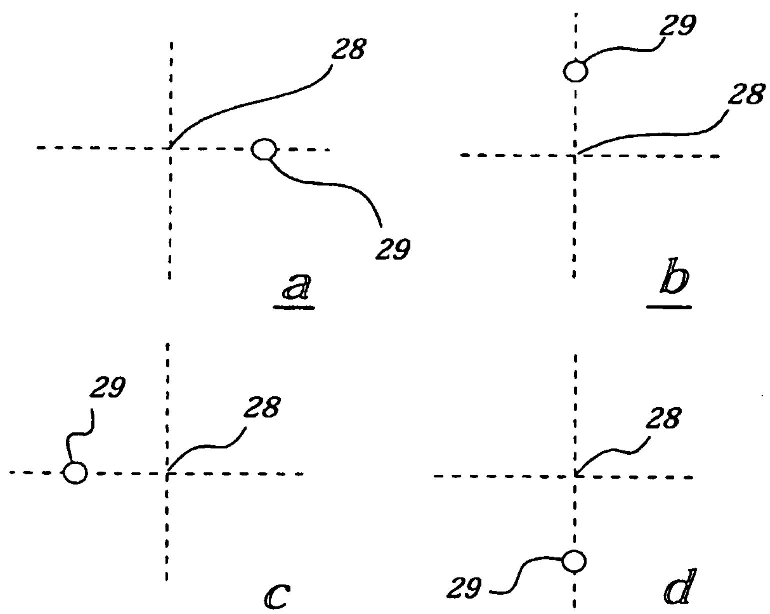

Fig. 4

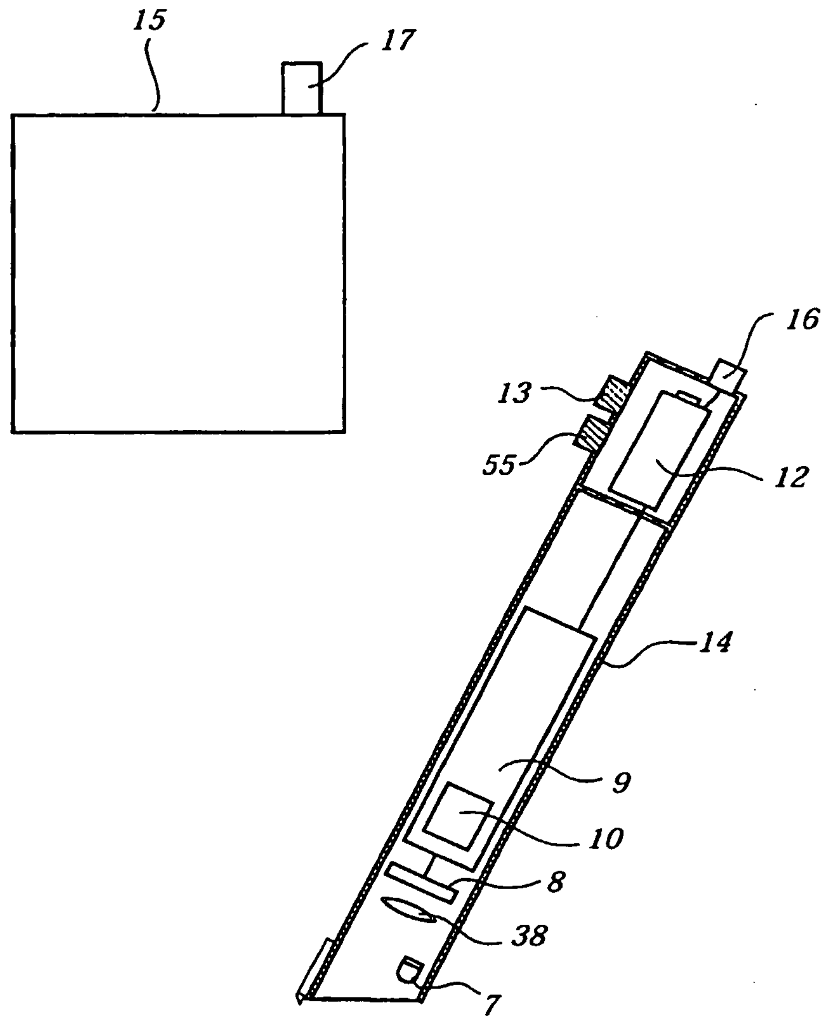

Fig. 6

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Information on patent family members

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WO	9217859	A1	15/10/92	DE	69202975	D,T	15/02/96
				EP	0578692	A,B	19/01/94
				GB	9106990	D	00/00/00
				GB	9120982	D	00/00/00
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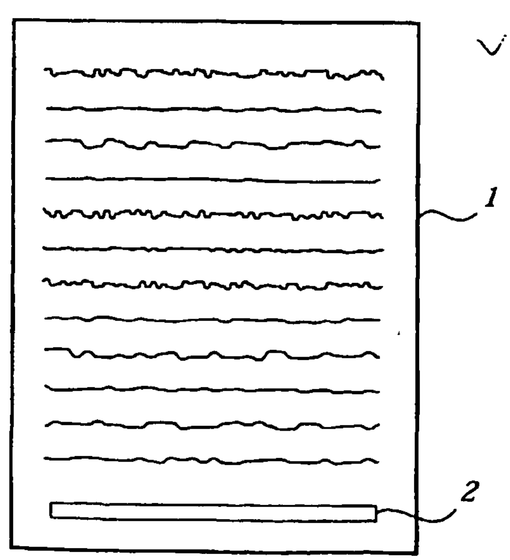

(57) Abstract: A product (1) with stored non-sequential data is provided by means of a method which comprises the step of coding the data (6, 52) to a coding pattern (2) by means of at least one sequence (32) with symbols (3, 24) which have the characteristic that an arbitrary subsequence of a predetermined magnitude of the sequence (32) unambiguously defines the position of the subsequence (34, 35) in the sequence. Then the coding pattern is reproduced on a product (1). A user unit is adapted to record and decode the coding pattern (2).

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METHOD AND SYSTEM FOR STORING A CODING PATTERN

Field of the Invention

The present invention relates to a method for storage of information or data and a device adapted to read data stored by means of the method.

Background Art

There are a plurality of known methods for storage of data. The traditional technique of storing written information is to store text in printed products such as books and newspapers. There are, however, several drawbacks of storing text in book form. One of the drawbacks is that books require much space. To achieve storage requiring less space, documents have for a long time been stored on microfiche. For a high degree of compaction, it is, however, necessary to use photographic films for such storage since ordinary paper has a strictly limited packing density. The storage alternatives to books which are advancing most rapidly are those based on the use of computers. A plurality of storage media for digital information are available. Examples of such storage media are RAM, magnetic media and optical media, such as optical discs. Another technique of storing information that can be read optically is bar codes which are used to a great extent in the retailing of everyday commodities when prices are included.

It is in some cases desirable to distribute text stored in a compact fashion. A drawback of using computers in such cases is that the user must then be electronically connected with the distributor of the stored information. An alternative is distributing microfiche or magnetic or optical data storage media containing the information that is to be distributed. However, it is relatively expensive to distribute data storage media or microfiche to a large group of people.

There is thus a need for an alternative method for compact storage of data and an alternative device for recording data stored by means of the method.

Summary of the Invention

An object of the present invention is to provide a method for compact storage of non-sequential data.

A further object of the present invention is to provide a method for compact storage of written text which allows easy distribution to a plurality of users without using electronic transmission.

One more object of the present invention is to provide a method for storage of a command which controls a computer.

Another object of the present invention is to provide a device for recording of information which has been stored by means of the method according to the present invention.

These and other objects are achieved by a method, a device and use according to the appended claims.

A basic idea of the present invention is to store text and other data by means of a matrix with symbols, which matrix can be recorded optically.

A method for storage of non-sequential data according to the invention is characterised in that it comprises the steps of coding the data to a coding pattern by means of at least one sequence with symbols which have the characteristic that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence, and reproducing the coding pattern on a product.

In this context, the term "product" relates to all possible articles on which a coding pattern can be applied. In the first place, sheets of paper in newspapers, books as well as loose sheets of paper are intended, but also other articles, such as bulletin boards, can be provided with a coding pattern.

Data relates to information such as text or other information. Data also relates to, for example, a command to a computer. This type of information is usually non-periodic.

The term non-sequential defines that the data is arbitrary in the sense that it is not a sequence of numbers in one or more dimensions. Such a sequence may easily be stored as a mathematical expression.

The product can be an arbitrary product on which one wants to have coded information. By coding the information by means of a sequence of the above type a code is made possible, which is relatively insensitive to how it is read by a user unit. At the same time, compact storage of the information is permitted. As mentioned above, the document may consist of any document whatever.

According to a preferred embodiment, the matrix is reproduced on a page in a book, the string of text being the text on the page of the book. It will thus be possible for a user to optically record the contents of the entire page of the book by recording the matrix with symbols.

Preferably, the data is converted into a set of data values, the pattern being arranged in such manner that it comprises portions of said at lest one sequence in a coding pattern, said portions being of at least the same magnitude as the subsequences of a predetermined magnitude, so that each of the data values codes a group each of at least two sequence portions in the coding pattern.

By coding the data in such manner that groups of at least two sequence portions are required for each data value, the coding pattern will be such that an arbitrary part of one sequence portion and the corresponding part of another sequence portion define a data value.

The data is advantageously coded with only one sequence so that the position of the subsequence in the sequence constitutes a sequence value and the relation-

ship between sequence values from different sequence portions defines the data values.

By using only one sequence, the coding and the recording of the coding pattern are simplified to a considerable extent. A user unit which is used to read the coding pattern can then process all parts of the coding pattern in the same way. It is also advantageous that only two sequence portions are required to code a data value since the coding pattern can then be made more compact.

Advantageously, each of the data values is defined by the difference between the sequence values for two subsequences from different sequence portions. Although some other relationship between the sequence values can be used, it is advantageous to use the difference between the sequence values since it simplifies the method when reading the coding pattern.

According to another embodiment each of the data values is defined by a single sequence value. According to this embodiment the subsequences are arranged in a pattern so that the subsequences are arranged separated from each other. Preferably, the subsequences are arranged in a row so that the symbols of the subsequences may be recorded in a single stroke with a reading pen.

The sequence portions are preferably juxtaposed in a matrix so that each of the data values is defined by the difference between the sequence values for two adjoining subsequences from corresponding parts of the sequence portions in the matrix. As a result, a user unit can easily convert the matrix and its subsequences with symbols into subsequences with values. It is possible for a user unit to convert the subsequences with values into data values. Since the data values are defined by difference values, the data values will be independent of which parts of the sequence portions are recorded.

It is, of course, possible to arrange the sequence portions in a way other than in a matrix. However, it

facilitates the recording of the sequence portions that they are arranged in a matrix.

The sequence portions advantageously code also at least part of a position value which defines the serial number of the sequence portion. This means that it is not necessary to record the entire coding pattern on the same occasion since the order of the different parts can be obtained from the position value. This facilitates recording of the matrix since a user unit which records the matrix can then decide whether sequence portions have already been recorded previously. In the case of missing certain sequences in connection with the recording when a user unit is scanned across the coding pattern, it will thus be possible to record the missed sequences on a later occasion and place them in the correct position by means of the position values. The position values are also of assistance when checking that no sequence has been missed.

Advantageously, part of a difference value defines part of a position sequence, which is arranged in such manner that an arbitrary position sequence part of a predetermined magnitude unambiguously defines the position of the position sequence part in the position sequence.

In the case where the difference values do not define position values, it is advantageous to reproduce the coding pattern on the product together with a marking which indicates a reading direction. Thus, it is ensured that the coding pattern and, thus, the data are not recorded in reverse order. If there is a position code, it is not necessary to have such a marking. The marking with the reading direction need be supplemented with the putting together of images so as to guarantee that each sequence is recorded only once.

Even if the data can be arbitrary data, it is preferably characters which are converted into data values. Alternatively, the data consists of, for example, a command to a computer.

The conversion of the characters into data values can be carried out in several ways. Advantageously, the text is first compressed by means of some prior art compressing method so that the data that is to be coded is minimised. Then each character in the coded data is converted into data values.

Preferably, the matrix is arranged in such manner as to comprise only columns with sequences which define sequence values. As a result, the matrix will be as compact as possible. It goes without saying that it is possible to arrange the matrix so as to comprise also other information.

According to a less preferred embodiment, the matrix also comprises other sequences with symbols. These can serve as delimitation between the sequences which define sequence values. However, the matrix will be less compact than in the case where the preferred embodiment is used.

On a product according to the invention data is stored in the form of a coding pattern which codes the data. The product is characterised in that the coding pattern codes the data, the coding pattern consisting of sequence portions with symbols which each comprise at least a subsequence of a sequence which is arranged so that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence.

A product according to the invention codes data in a more compact manner than does a bar code since a product according to the invention can have information stored in two dimensions.

Preferably, the coding pattern codes a set of data values, each of the data values being coded by a group each of sequence portions consisting of at least two sequence portions.

Consequently a code is permitted, which can be made independent of the reading in one dimension.

The symbols on a product according to the invention can have many different kinds of appearance. According to an embodiment, the symbols consist of markings, the size of the markings defining the value of the symbol.

According to an alternative embodiment, each of the symbols comprises a raster point and a marking, the value of each symbol being indicated by the position of said marking in relation to the raster point.

A user unit for optical recording of information according to the present invention comprises an image sensor and is adapted to optically record images from a surface by means of the image sensor. The user unit is characterised in that it is adapted, in response to the fact that a recorded image comprises a predetermined number of subsequences with symbols, each of the subsequences unambiguously corresponding to a position in a predetermined sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude unambiguously defines a position in the sequence, to convert the predetermined number of subsequences into data.

Preferably, the user unit also comprises a memory intended for storage of data which corresponds to the data value. Data stored in the memory can then be transmitted to some other unit, such as a computer.

Instead of, or together with, a memory, the user unit may comprise a display and can be adapted to show on the display data which corresponds to the data value.

The user unit can be equipped with a loudspeaker via which the user unit is adapted to transmit sound corresponding to the data.

A user unit according to the invention is advantageously adapted to convert the predetermined number of subsequences into data values and to convert each data value into only one character. This means that the memory can be small since a reference table which is stored in

the memory need only contain connections between the number of characters used and their corresponding symbols.

Alternatively, a user unit according to the present invention is adapted to convert each data value into one or more characters. Thus, the data values are converted into entire words, word parts or endings. A matrix which is made up in this manner will, of course, be more compact than if each character has its own data value. A drawback is, however, that a larger memory is necessary in the user unit. Besides, that part of the matrix which need be recorded for a word to be defined must be larger than if each character has its own data value.

Of course, the user unit is adapted to convert the coding pattern in dependence on how it is created.

Thus the coding pattern is converted in reverse order to how it has been stored.

The conversion of the subsequences with symbols into data values is preferably made by converting the symbols into values, converting the subsequences with values into sequence values, calculating the differences between the sequence values and converting the differences into data values.

The user unit is advantageously adapted to use part of the difference between the sequence values for determining the relative positions of the subsequences. Since more than one image is recorded in the inputting of a matrix, there is a risk that certain parts of the matrix are recorded in more than one image. By the user unit using part of the difference to determine the relative positions of the sequence parts, it is possible to exclude such information as corresponds to sequence parts that have already been recorded.

Since the conversion between data and data values is carried out by means of a predetermined relationship, the user unit must have information about how the data was converted into data values when the matrix was formed.

A memory medium according to the invention can be read by a computer and has a program stored thereon. The memory medium is characterised in that the program makes a computer record an input signal corresponding to an image, and, in response to the fact that the image comprises a predetermined number of subsequences with symbols, each of the subsequences unambiguously corresponding to a position in a predetermined sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude unambiguously defines a position in the sequence, convert the predetermined number of subsequences into data.

Such a program can be executed in an arbitrary computer but is advantageously executed in a reading pen which comprises the necessary hardware for recording images.

If the coding pattern is printed by a carbon-based black ink absorbing infrared light and the printed text is printed with an ink which is not carbon-based and does not absorb infrared, the coding pattern may be sensed by an infrared sensor, without interference by the printed text.

The above features can, of course, be combined in the same embodiment.

With a view to further elucidating the invention, detailed embodiments thereof will be described below, without the invention however being considered to be restricted thereto.

The accompanying drawings are only schematic and, thus, certain dimensions are greatly exaggerated so as to illustrate the invention more distinctly.

Brief Description of the Drawings

Fig. 1 shows a document in the form of a page in a book with a coding pattern according to a preferred embodiment of the present invention.

Fig. 2 illustrates in more detail the coding pattern in Fig. 1.

Fig. 3 illustrates a sequence which can be used to code data according to the present invention.

Fig. 4 shows an embodiment of symbols which can be used in the coding pattern in Figs 1 and 2.

Fig. 5 shows how part of the coding pattern is converted into characters.

Fig. 6 shows a user unit according to a preferred embodiment of the invention.

Fig. 7 shows the conversion of a matrix into data values and a position value.

Fig. 8 shows the conversion of the coding pattern into sequence values.

Fig. 9 shows how part of an alternative embodiment of a coding pattern is converted into data values.

Detailed Description of the Invention

Fig. 1 shows a document 1 with a coding pattern according to a preferred embodiment of the present invention. The coding pattern consists of a matrix whose outer boundary 2 is marked with the frame 2.

Fig. 2 shows in more detail the coding pattern 2. The matrix comprises a plurality of symbols 3 arranged in sequence portions 4 in columns in the matrix, each symbol 3 defining the value "0", "1", "2", or "3". Each column with symbols is a sequence portion of a sequence with 512 symbols. An arbitrary subsequence, which consists of five symbols, defines unambiguously the position of the subsequence in the sequence. The sequences in the different columns are displaced in relation to each other. Fig. 1 also shows a marking 31 which indicates in which direction the matrix is to be recorded for the string of characters to be recorded. In Fig. 2, all symbols are marked with identical symbols. However, the symbols are of course different dependent on which value they represent.

Fig. 3 illustrates the appearance of a sequence 32 which is used in the invention. The sequence 32 comprises 512 values 33, each of which is either "0", "1", "2", or

"3". An arbitrary subsequence 34, 35 with 5 values defines unambiguously a sequence value which corresponds to the position of the subsequence in the sequence 32. Each subsequence appears only once in the sequence. Thus, the first subsequence 34 corresponds to the value "0" and the second subsequence 35 to the value "1". In Fig. 2, the columns consist of sequence portions of such sequences in which the values have been converted into symbols. Sequences of this kind are described in "Pseudo-Random Sequences and Arrays" by F. Jessie MacWilliams and Neil J. A. Sloane in "Proceedings of the IEEE Vol. 64, No. 12, December 1976".

Figs 4a-d show an embodiment of a symbol which can be used in the matrix in Fig. 1 according to the invention. The symbol comprises a virtual raster point 28 which is represented by the intersection between the raster lines, and a marking 29 which is in the form of a point. The value of the symbol depends on where the marking is located. In the Example in Fig. 4, there are four possible locations, one on each of the raster lines extending from the raster points. The displacement from the raster points is the same for all values. The symbol has in Fig. 4a the value "0", in Fig. 4b the value "1", in Fig. 4c the value "2" and in Fig. 4d the value "3". In other words, there are four different types of symbols. Each symbol can thus represent four values "0-3".

Fig. 5 shows a part 5a of the matrix 2 in Fig. 1 in greater detail. The submatrix 5 contains five subsequences 36 arranged in columns in the submatrix. Fig. 5a also shows the virtual raster 37 in relation to which the symbols are arranged. Fig. 5 b shows the matrix when the symbols have been converted into values.

Fig. 6 shows a user unit according to a preferred embodiment of the present invention. The user unit is a reading pen 14 which is arranged for recording a coding pattern as shown in Fig. 2. The reading pen is intended to be held by the user's hand to record images from a

base. The reading pen comprises a light-emitting diode 7 for illuminating the surface which is to be recorded, an image sensor 8 in the form of a CCD for recording of images, an image processing means 9 and a memory 10. In front of the CCD there is arranged a lens system 38 which is intended for imaging of the coding pattern on the CCD. The reading pen 14 further comprises a battery 12 for power supply and buttons 13 by means of which the reading pen is switched on. The reading pen is provided with a transmitter 16 for transmitting recorded information to a computer 15, which in turn is provided with a receiver 17 for receiving information from the reading pen. The transmitter and the receiver communicate, for example, by IR or by radiowaves. The information recorded by means of the reading pen can, consequently, easily be transmitted to the computer for further processing. The reading pen is also provided with a display 21 for presentation of the information recorded by means of the reading pen 14. The reading pen 14 is also provided with a loudspeaker 55 to transmit sound corresponding to the data.

With reference to Figs 2, 5 and 6, the recording of a coding pattern will now be described. When the reading pen is passed across the matrix 2 with symbols 3, an area is recorded, which at least comprises a first area 5 comprising a submatrix of the size five times five symbols 3. The symbols are one of the four different symbols shown in Fig. 4. The image processing means 9 converts the recorded image into a matrix with five times five symbols. Then the reading pen converts the subsequences 36 in the matrix into subsequences 39 with values 40. Each subsequence with values correspond to a sequence value 27 which corresponds to the position in a sequence with 512 values, each of which is either "0", "1", "2" or "3". If an image is recorded which is displaced one row in the matrix, sequence values are obtained, which correspond to the next position in the sequence. The user unit converts the subsequences 39 into sequence values 27.

Then the user unit calculates data values 26 as the difference modulo 1024 between the sequence values 27 for adjoining columns. By the sequence values 27 increasing to the same extent for each column if the recorded image is displaced in the direction of the column, the data values, which equal the difference between the sequence values 27, are independent of the height at which the image is recorded. The data values are then converted into binary form and the eight least significant bits in each data value are converted into characters 6 which are stored in the memory 10, while the two most significant bits from four adjoining data values are converted into a position sequence part. Thus it is possible to code a total of 256 different characters. The position sequence part constitutes part of a position sequence similar to the sequence in Fig. 3 and defines unambiguously a position in the position sequence and constitutes a position value for the columns.

In Fig. 5, the characters 6 are characters in a text. However, it is preferred for the characters 6 to be characters in a compressed text so that the string of characters which consists of the characters 6 need be converted so as to obtain text en clair.

The position values for the columns are used to determine whether a character from a subsequently recorded image has already been stored in the string of characters in the memory. This is usable since the next image which is recorded comprises, for example, a second area 22 which comprises parts of the first area 5. When the subsequences in the second area 22 are converted into characters, the characters will partly be the same as those recorded when the first area 5 was recorded. By the position value being given by the difference values, the previously stored characters can be dropped. A coding pattern codes, for example, the series [(0, 12), (1, 25), (2, 37), (3, 82), (4, 24), (5, 16)] in which the first value in each pair of values corresponds to a position

value and the second value corresponds to a data value. In a first image, the series [(0, 12), (1, 25), (2, 37), (3, 82)] is recorded. In a second image, the series [(2, 37), (3, 82) (4, 24), (5, 16)] is recorded. Thus, the values "37" and "82" are recorded twice. The position values indicate, however, that they have been recorded even the first time, which makes it possible to produce the correct series once more.

A further example of when the positions of the subsequences are important is when the reading pen is quickly passed across the coding pattern. Then there is a risk that some information is not recorded. By having a position code in subsequences, it will be possible to pass the reading pen across the coding pattern once more, thereby recording the information that was not recorded the first time. This is illustrated in Fig. 7. Fig. 7 shows a small part 43 of a coding pattern in the form of a plurality of symbols 42 arranged in columns 45 in a matrix. It is thus sufficient to record a subsequence consisting of five symbols of each column 45. When the reading pen is passed across the coding pattern, several images are recorded. A first image 39 and a second image 40, which are recorded by the reading pen, are separated. Since some of the symbols in the pattern have not been recorded in an image, some information is missing. It is then possible to pass the reading pen across the coding pattern a second time to record a third image 46 which contains information from the columns that were missing in the first image 39 and in the second image 40. By the subsequences containing position information, it is possible to enter the information from the third image 46 in the correct position in relation to the information from the first image 39 and second image 40. A coding pattern codes, for example, the series [(0, 12), (1, 25), (2, 37), (3, 82) (4, 24), (5, 16)], where the first value in each pair of values indicates the position value and the second value indicates the data value. In a first record-

ing, the series [(0, 12), (1, 25), (2, 37), (4, 24), (5, 16)] is recorded. In a second recording, the series [(0, 12), (1, 25), (2, 37), (3, 82) (4, 24)] is recorded. Since the data value "82" which corresponds to the position value "3" is included in the second series, the complete series can be produced.

According to a preferred embodiment, each difference value codes only part of a position value. This is illustrated in Fig. 7. The matrix 53 with symbols 54 is converted into sequence values S_1-S_5 in the same manner as described above. The difference between the sequence values forms a set of data values D_1-D_4 and a set of subposition values P_1-P_4 which together form a sequence defining a position value which indicates the position of the matrix in the coding pattern.

Fig. 8 also illustrates how the information from images, which have been recorded at different heights in the matrix, is processed. The first image 40 contains five times five symbols. The symbols are converted into values as described in connection with Fig. 5. The values in the columns are then converted into sequence values which correspond to the position of the subsequence in the sequence. The five subsequences with symbols which correspond to the columns in the first image 40 are thus converted into a first set of five sequence values 47. The first set of five sequence values 47 is then converted into a first set of difference values 48, which in turn are converted into characters in the same way as described in connection with Fig. 5. When a third image 41 containing five times five symbols is recorded, the five subsequences consisting of five symbols are converted into a second set of five sequence values 49. The second set of five sequence values 49 is then converted into a second set of difference values 50 which in turn are converted into characters in the same way as described in connection with Fig. 5. Each of the sequence values 49 in the second set is four units greater than the

sequence values 47 in the first set since they are fetched further down in the sequences of which the sequence parts consist a part. However, each of the difference values 48 in the first set of difference values is equal to the corresponding difference value in the second set of difference values. Thus, the difference values are independent of at what height in the matrix 43 the images have been recorded.

When producing the matrix in Fig. 5, each character 6 in a string of characters is first converted into data values by means of a reference table which is stored in the memory. The data values consist of eight bits. Difference values 26 are then produced by adding position information in the form of two binary bits to the data values. The position information 30 is selected in such manner that four successive difference values 26, 48, 50 give a position subsequence which unambiguously defines a position value which gives a position subsequence which unambiguously determines a position in a position sequence. Parts of identical sequences are then arranged in columns in the matrix. The identical sequences are such that a subsequence with five successive values from the sequence unambiguously determines a sequence value 27 which corresponds to the position of the subsequence in the sequence. The parts of the sequences are arranged in such manner that the set of differences between the sequence values for the sequence parts, which have been taken from the same rows in the matrix, corresponds to the difference values 27. Subsequently the values 40 in the sequences are converted into symbols 3.

In fig 9 another embodiment of a coding pattern is shown in which the entire coding pattern has a height 64 corresponding to the length of a subsequence, i.e. five symbols 60 in this case. The coding pattern is of a similar type as described in connection with fig. 5, i.e. the value of a symbol depends on the position of a marking 60 in relation to a virtual raster with raster lines

65. The distance 61 between different raster lines 65 is 0.3 mm in this embodiment. With this distance between the raster points the coding pattern becomes considerably robust while at the same time being compact. The symbols in the square 66 are converted into subsequences 62 as described in connection with fig 5. The subsequences are in turn converted into sequence values 63. According to this embodiment each sequence value correspond to a character and a position code. The sequence value "96" corresponds for example to the character " " (space) and the position code "17". According to this embodiment of the invention the reading pen thus has to record all symbols in the height of the coding pattern in order to be able to convert into text. An advantage of this embodiment is that each character may be recorded by recording only one column of symbols.

In a preferred embodiment, 6*6 symbols are used for coding the pattern. A more detailed explanation of how the coding is done appears from Applicant´s PCT patent applications Nos. WO 00/73983, PCT/SE00/1667 and WO 01/16691, the contents of which are included in the present specification by reference.

The above embodiments are to be considered examples only.

A person skilled in the art realises that the above embodiments can be varied in a number of ways without departing from the inventive idea. For example, it is not necessary that the user unit be a single integrated unit.

It is not necessary for the invention that a display be arranged directly on the user unit.

Although the examples above only illustrate that the sequence portions are arranged in columns in a matrix, this is not necessary for the invention. The sequence portions can be arranged in an arbitrary manner.

It goes without saying that the sequences that are used to code the data need not be 512 character long.

Of course any number of symbols may be used to code a value.

CLAIMS

1. A method for storage of non-sequential data, c h a r a c t e r i s e d in that it comprises the steps of

coding the non-sequential data (6, 52) to a coding pattern (2) by means of at least one sequence (32) with symbols which have the characteristic that an arbitrary subsequence (34, 35) of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence (34, 35) in the sequence (32), and

reproducing the coding pattern (2) on a product.

2. A method as claimed in claim 1, c h a r a c t e r i s e d in that it also comprises the step of converting the data (6, 52) into a set of data values (26), the pattern being arranged so as to comprise sequence portions of said at least one sequence in a coding pattern, said sequence portions being at least of the same magnitude as the subsequences of a predetermined magnitude, so that each of the data values is coded by a group each of at least two sequence portions (4) in the coding pattern.

3. A method as claimed in claim 1, c h a r a c t e r i s e d in that it also comprises the step of converting the data (6, 52) into a set of data values (26), the pattern being arranged so as to comprise sequence portions of said at least one sequence in a coding pattern, said sequence portions being of the same magnitude as the subsequence of a predetermined magnitude, so that each of the data values is coded by one sequence portion (4) in the coding pattern.

4. A method as claimed in claim 2, c h a r a c t e r i s e d in

that the data (6, 52) is coded with only one sequence (32),

that the position of a subsequence in the sequences constitutes a sequence value (27) and

that the relationship between the sequence values (27) from different sequence portions (4) defines the data values.

5. A method as claimed in claim 2 or 4, characterised in that each of the data values is defined by the difference between the sequence values (27) for two subsequences (39) from different sequence portions.

6. A method as claimed in claim 5, characterised in that the sequence portions (4) are juxtaposed in a matrix (2) in such manner that each of the data values is defined by the difference between the sequence values (27) of two adjoining subsequences from corresponding parts of the sequence portions in the matrix (2).

7. A method as claimed in any one of claims 2-6, characterised in that the sequence portions also code at least part (30) of a position value which defines the serial number of the sequence portion.

8. A method as claimed in any one of the preceding claims, characterised in that the data is characters, and that the characters are converted into data values.

9. A product on which non-sequential data (6, 52) in the form of a coding pattern (2) is stored, which codes the data (6, 52) characterised in that the coding pattern (2) consists of sequence portions (4) with symbols (3) which each comprise at least a subsequence of a sequence which is arranged so that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence.

10. A product as claimed in claim 9, characterised in that the coding pattern codes a set of data values, each of the data values coding a group each

of sequence portions (4) consisting of at least two sequence portions.

11. A product as claimed in claim 9 or 10, c h a r a c t e r i s e d in that the symbols (3, 24) consist of markings, the size of the markings defining the value of the symbol.

12. A product as claimed in claim 9 or 10, c h a r a c t e r i s e d in that each of the symbols (3, 24) comprises a raster point (28) and a marking (29), the value of each symbol being indicated by the position of said marking (29) in relation to the raster point (28).

13. A product as claimed in any one of claims 9, 10, 11 or 12, c h a r a c t e r i s e d in that the product (1) is a sheet of paper.

14. A product as claimed in any one of claims 9-13, c h a r a c t e r i s e d in that the coding pattern (2) codes text.

15. A product as claimed in any one of claims 9-13, c h a r a c t e r i s e d in that the coding pattern (2) codes a command.

16. A user unit for optical recording of information, which comprises an image sensor (8) and which user unit (11) is adapted to optically record images from a surface by means of the image sensor (8), c h a r a c t e r i s e d in that it is adapted, in response to the fact that a recorded image comprises a predetermined number of subsequences with symbols, each of the subsequences unambiguously corresponding to a position in a predetermined sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude unambiguously defines a position in the sequence, to convert the predetermined number of subsequences into non-sequential data (6, 52).

17. A user unit as claimed in claim 16, c h a r a c t e r i s e d in that it also comprises a display, and that it is adapted to show data on the display.

18. A user unit as claimed in claim 16, c h a r a c t e r i s e d in that it further comprises a loudspeaker, and that it is adapted to transmit, by means of the loudspeaker, sound corresponding to the data value.

19. A user unit as claimed in any one of claims 16-18, c h a r a c t e r i s e d in that it is adapted to convert the symbols (3, 24) into subsequences with values,

to convert the subsequences with values into sequence values (27),

to calculate difference values (26) as the difference between the sequence values (27),

to convert the difference values (26) into data values, and

to convert the data values into data (6, 52).

20. A user unit as claimed in claim 19, c h a r a c t e r i s e d in that some of the difference values (26) are used to determine the relative positions of the subsequences.

21. A user unit as claimed in claim 20, c h a r a c t e r i s e d in that it is adapted to use the relative position of the subsequences to decide whether data (6, 52) corresponding to a data value has been previously recorded.

22. Use of a coding pattern for storage of text, said coding pattern (2) consisting of sequence portions (4) with symbols (3) which each comprise at least a subsequence of a sequence which is arranged in such manner that an arbitrary subsequence of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence in the sequence.

23. A computer-readable memory medium, on which a program is stored, c h a r a c t e r i s e d in that the program makes a computer (14)

record an input signal corresponding to an image, and

in response to the fact that the image comprises a predetermined number of subsequences with symbols (3, 24), each of the subsequences unambiguously corresponding to a position in a predetermined sequence (32) which is arranged in such manner that an arbitrary subsequence (34, 35) of a predetermined magnitude unambiguously defines a position in the sequence (32), convert the predetermined number of subsequences into non-sequential data.

24. A storage medium as claimed in claim 23, characterised in that the program makes the computer output a signal to a display unit for presentation of the data.

25. A method for storage of non-sequential data, characterised in that it comprises the steps of

converting the data (6, 52) into a set of data values (26),

coding the data values (26) to a coding pattern (2) by means of at least one sequence (32) with symbols which have the characteristic that an arbitrary subsequence (34, 35) of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence (34, 35) in the sequence (32), the pattern being arranged so as to comprise sequence portions of said at least one sequence in a coding pattern, said sequence portions being at least of the same magnitude as the subsequences of a predetermined magnitude, wherein the sequence portions also code at least part (30) of a position value which defines a serial number of the sequence portion, and

reproducing the coding pattern (2) on a product.

26. A method for storage of data, characterised in that it comprises the steps of

coding the data (6, 52) to a coding pattern (2) by means of at least one sequence (32) with symbols which have the characteristic that an arbitrary subsequence

(34, 35) of a predetermined magnitude of the sequence unambiguously defines the position of the subsequence (34, 35) in the sequence (32), and

reproducing the coding pattern (2) on a product.

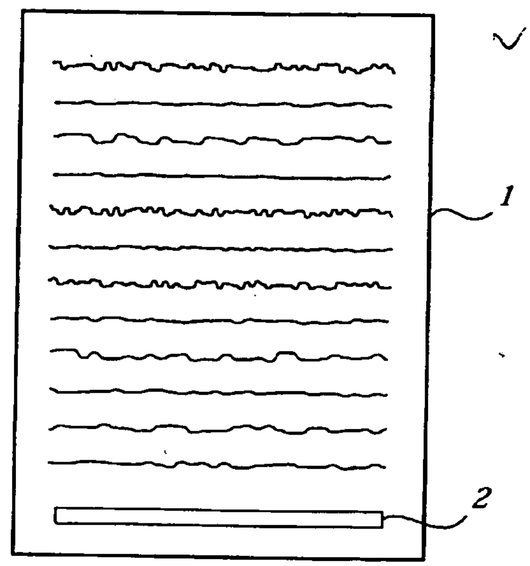

Fig. 1

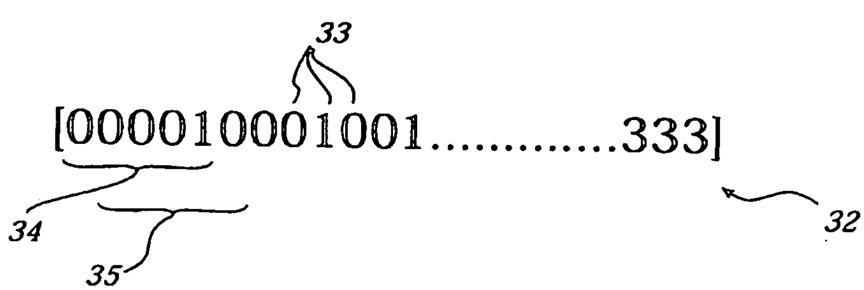

Fig. 3

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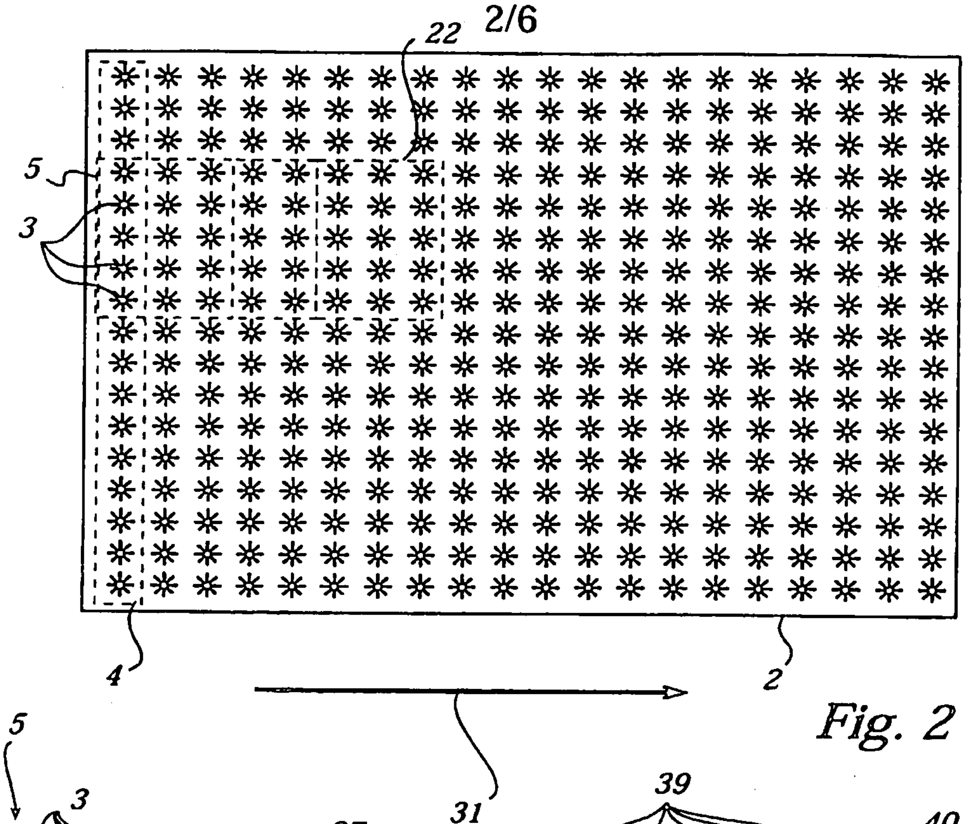

Fig. 2

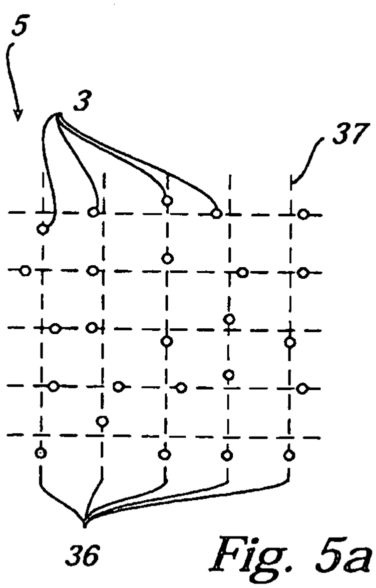

Fig. 5a

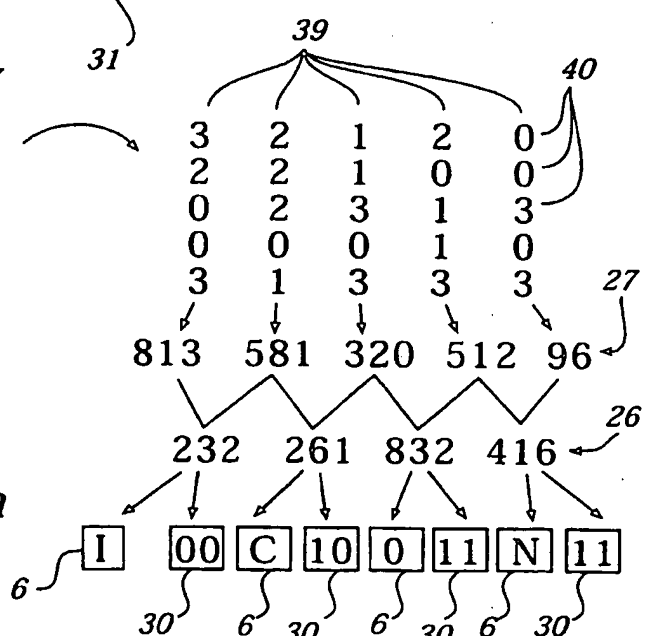

Fig. 5b

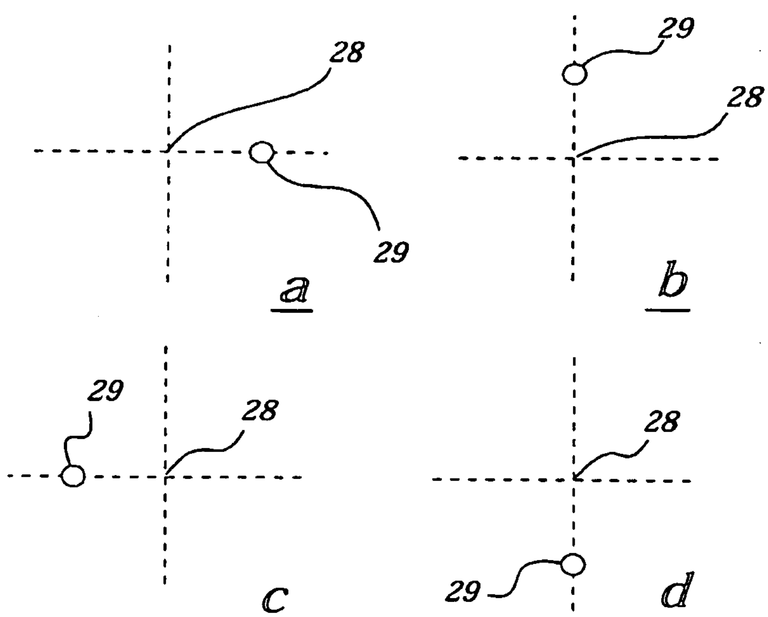

Fig. 4

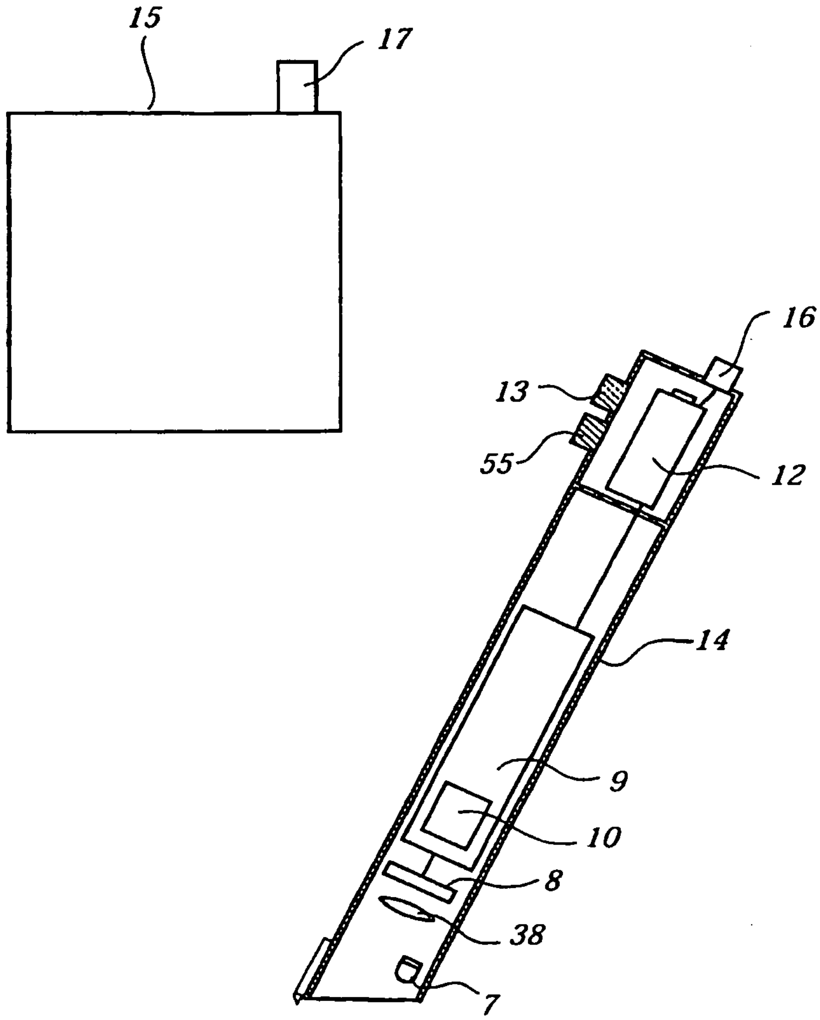

Fig. 6

INTERNATIONAL SEARCH REPORT
Information on patent family members

28/05/01

International application No.
PCT/SE 01/00596

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9217859 A1	15/10/92	DE 69202975 D,T	15/02/96
		EP 0578692 A,B	19/01/94
		GB 9106990 D	00/00/00
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		JP 6506080 T	07/07/94
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US 5661506 A	26/08/97	NONE	